

Overview of the DONES Programme

P. Cara on behalf of the DONES Integrated Programme Team

DONES

Madrid, October 13th 2026

Outline

1. DONES Programme
2. IFMIF-DONES Facility
3. DONES Irradiation Capabilities
4. DONES Experimental Programme
5. Outlook & Summary

Outline

1 DONES Programme

DONES Mission and Objectives

DONES Programme Mission

- To test materials and to develop a comprehensive database on the effects of fusion-like neutron irradiation on the materials required for the construction of fusion power reactors
- Support advancements in other fusion technologies such as tritium technologies

DONES Programme Objectives

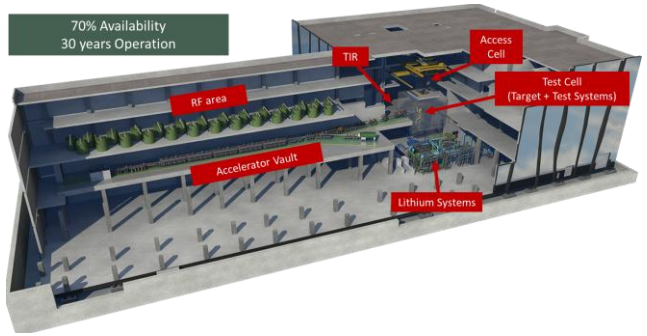
- To provide a neutron source producing fusion-like neutrons at sufficient intensity and irradiation volume
- Generate materials irradiation test data for DEMO
- Generate data base for benchmarking with computational material science

Requirements

- **Neutron spectrum** closely replicating fusion power plants (PKA, transmutation reactions, gas production (He, H)
- **Neutron fluence**:
  - >20 dpa_{NRT} <2.5 years >0.3 l
  - >50 dpa_{NRT} <3.years >0.1 l
- **Temperature**-controlled @ test modules 250-550 ºC
- **Dpa gradient** <15% at the gauge HF test volume
- **Temperature gradient** <+/- 3% at the gauge HF test volume
- Irradiation of **multiple modules** simultaneously

The IFMIF-DONES Facility

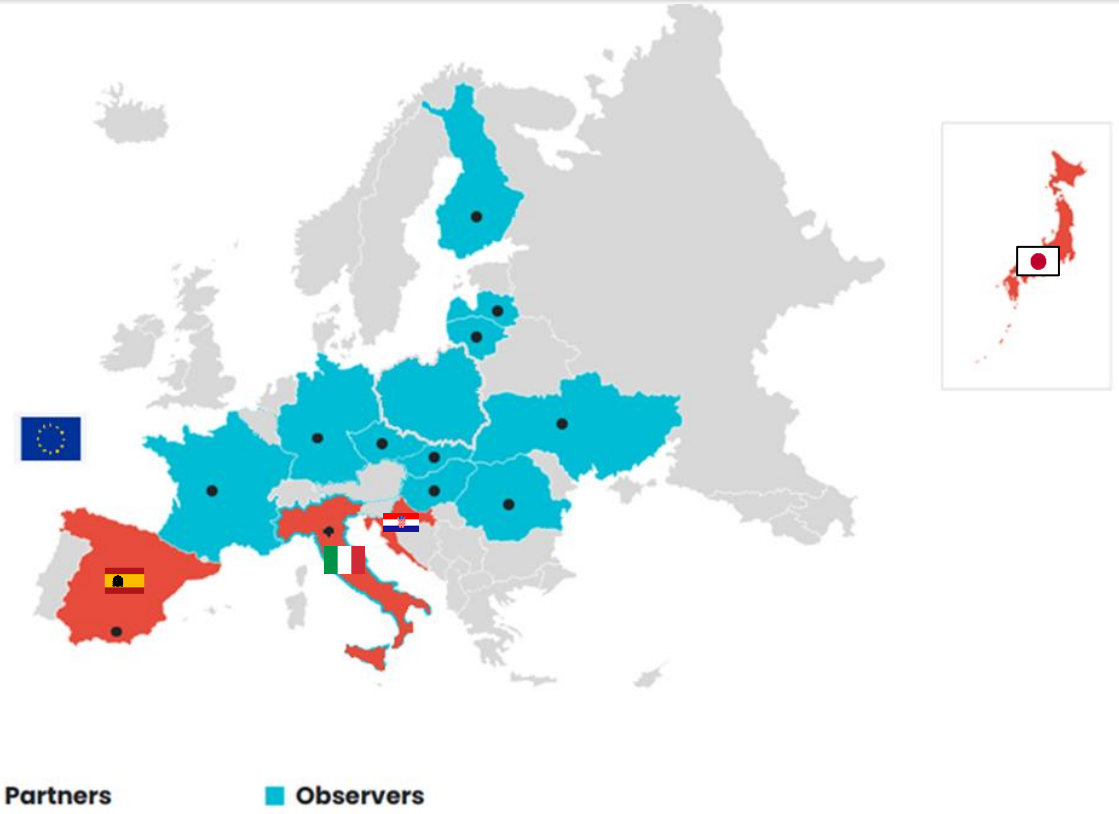
D-Li neutron source,125 mA cw, 40 MeV



DONES Programme Governance

Signature of the
Multilateral International DONES Agreement
MIDA
21st November 2025





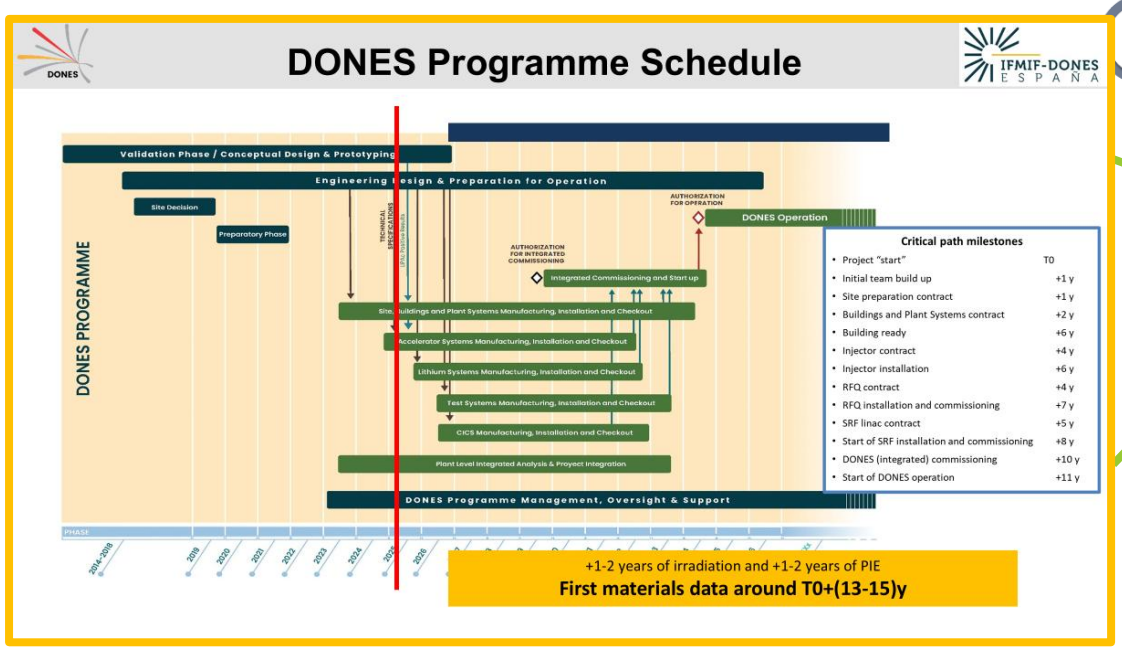
Current Parties

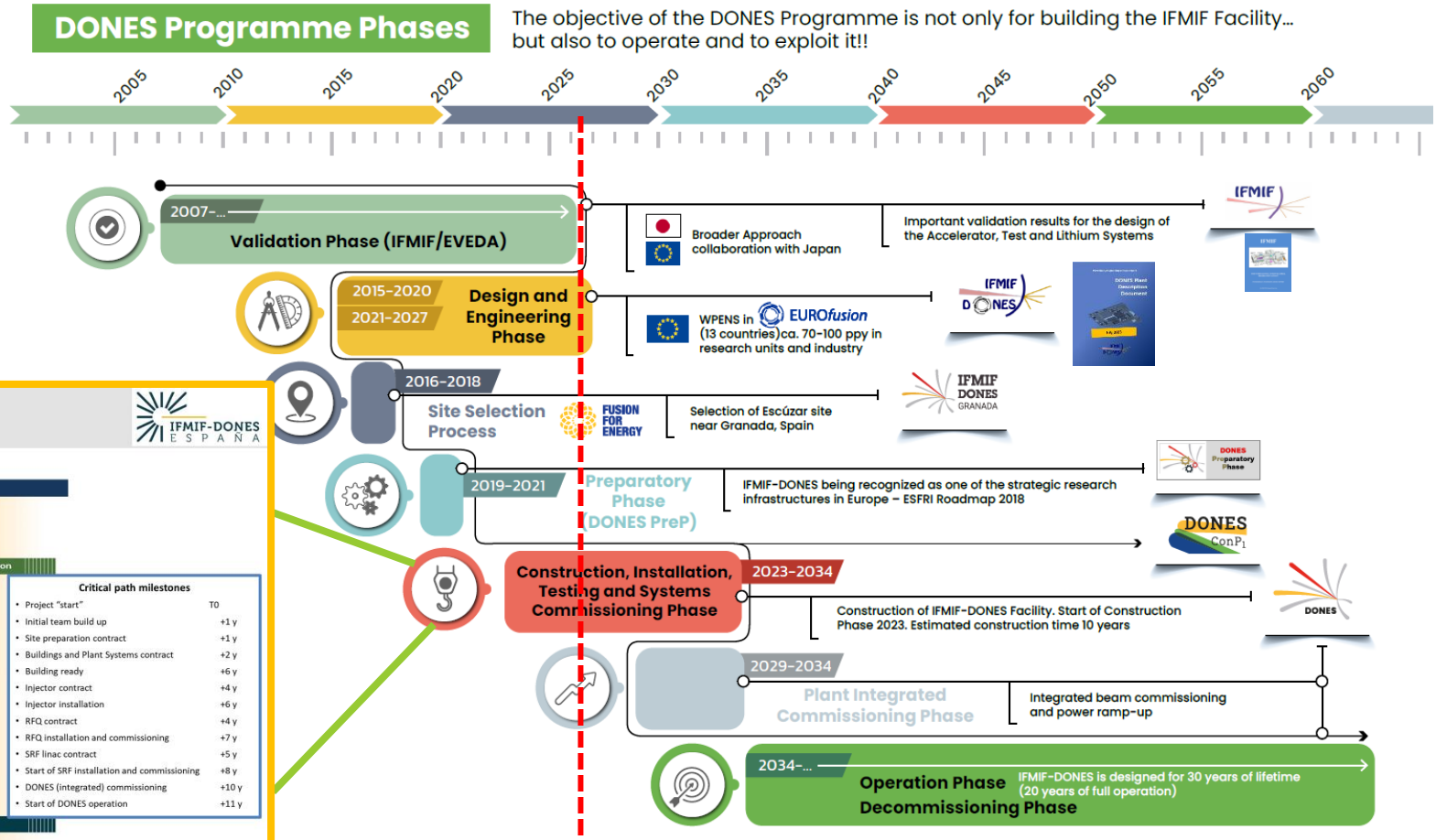
- *F4E (European Commission)*
- *IFMIF-DONES España (Spain, Host)*
- *INFN (Italy)*
- *QST (Japan)*
- *RBI (Croatia)*
- *ENEA (TBC)*

Observers:

- *Czech Republic*
- *Canada (TBC)*
- *Finland*
- *France*
- *Germany*
- *Hungary*
- *Latvia*
- *Lithuania*
- *Poland*
- *Romania*
- *Slovakia*
- *Ukraine*

DONES Timeline





Outline

2 IFMIF-DONES Facility

IFMIF-DONES Facility

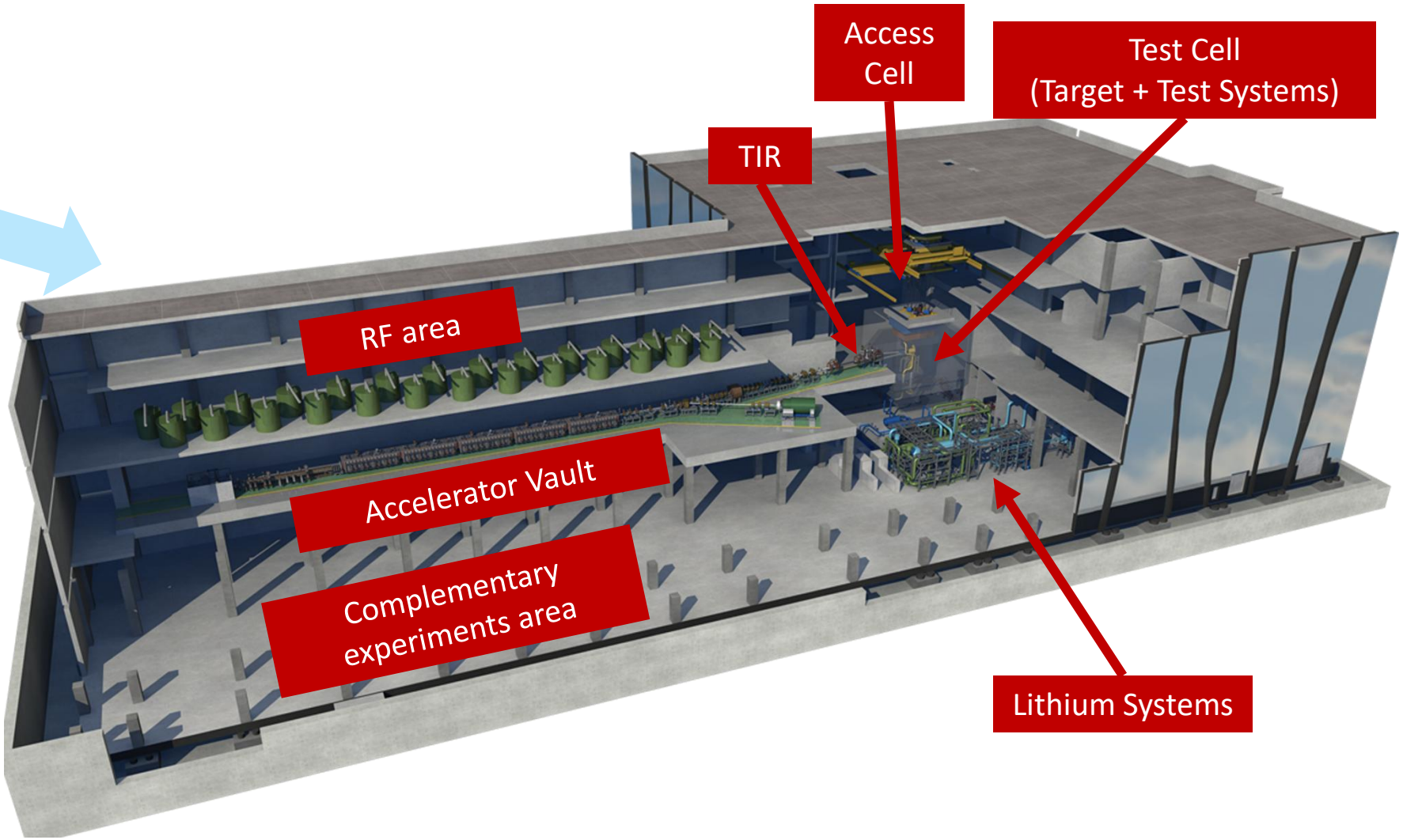
70% Target Availability
30 years Operation



Site, Building & Plant Systems

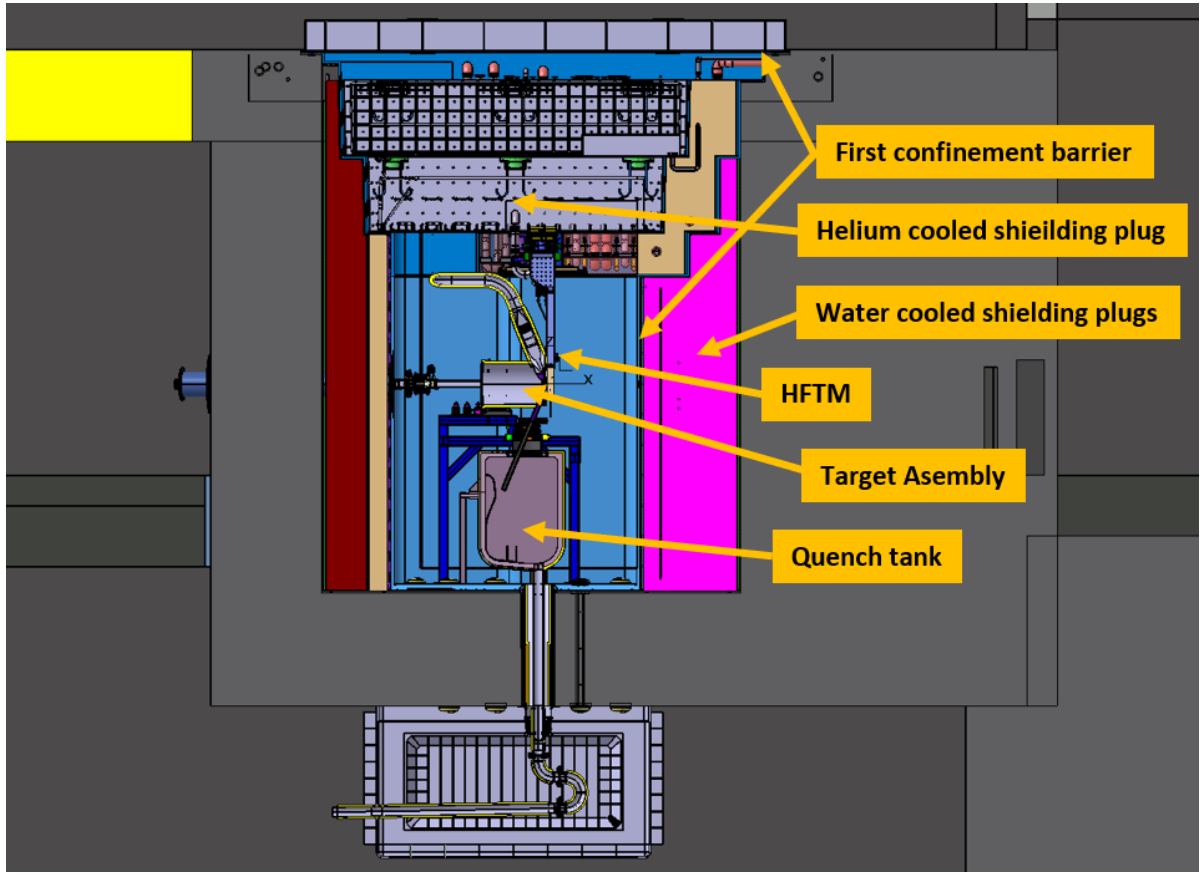
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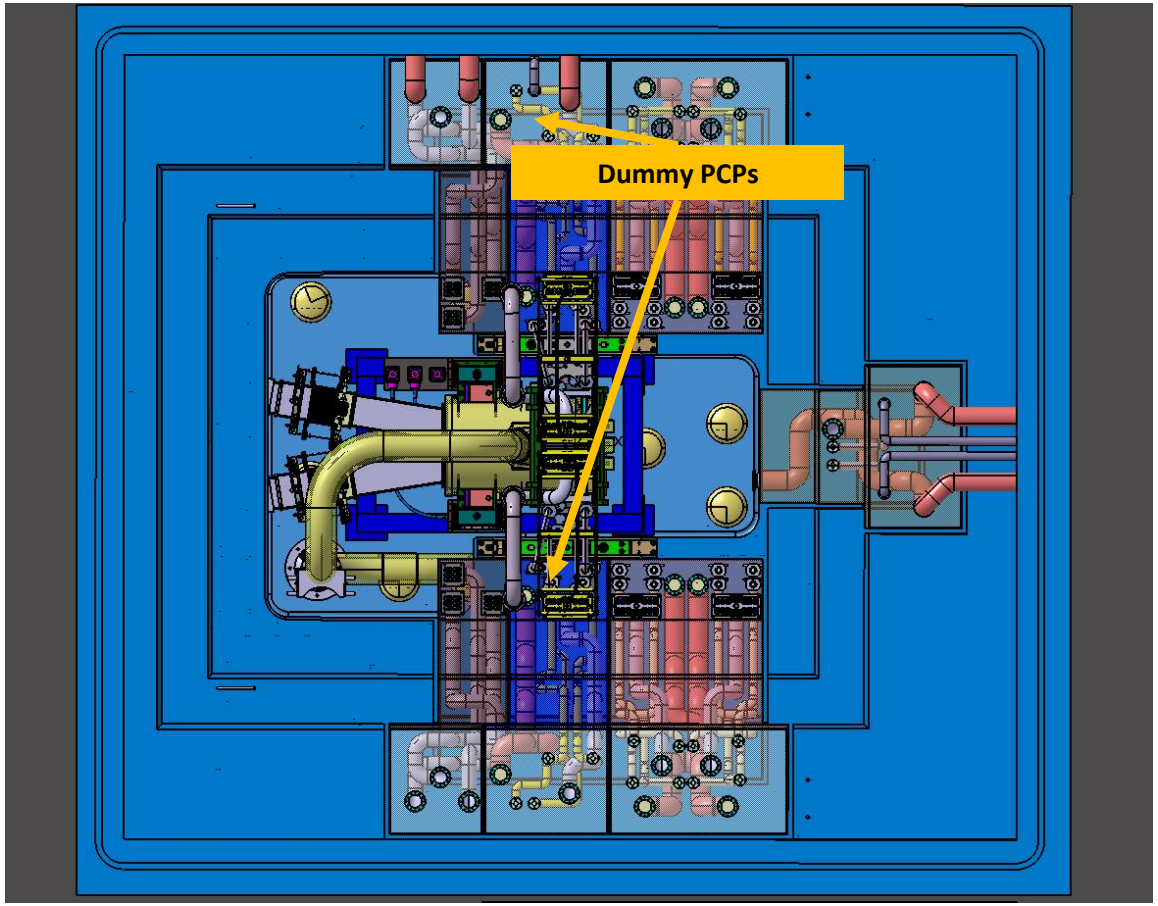


Test Systems – Test Cell

Side view



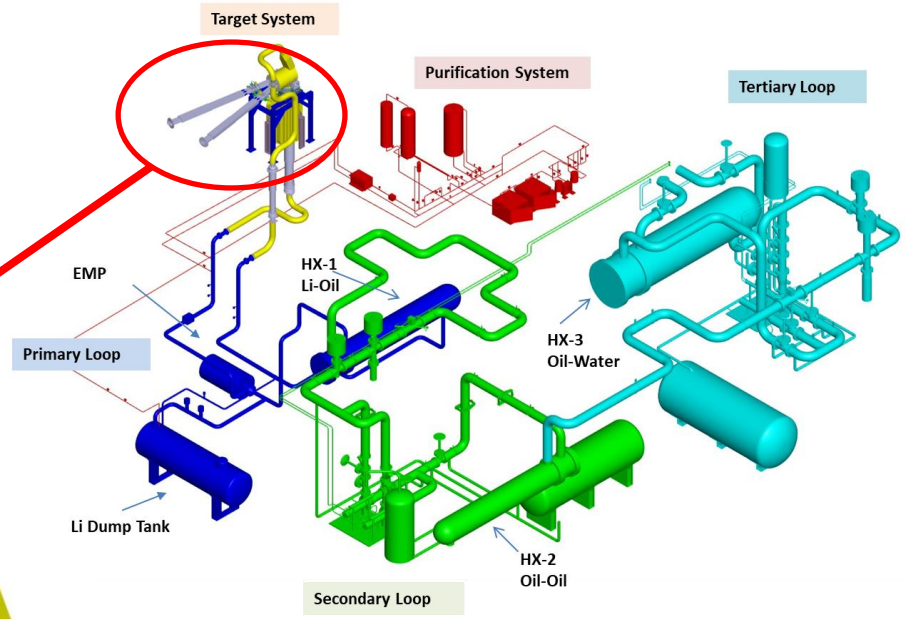
Top view



Liquid Lithium Target

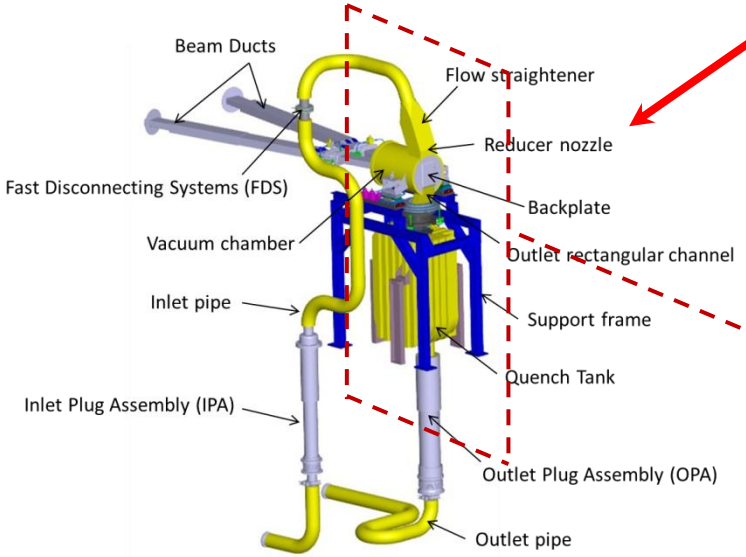
- **5 MW** power handling (ready for 10 MW)
- **Interaction beam-target** (vac chamber, transients, vaporization...)
- Three **heat rejection loops** (Li-Oil, Oil-Oil, Oil-Water)
- **Impurities** control and monitoring
  - Corrosion issues (affected by N content)
  - Radioactivity inventory (Be-7, Tritium, ACP…)

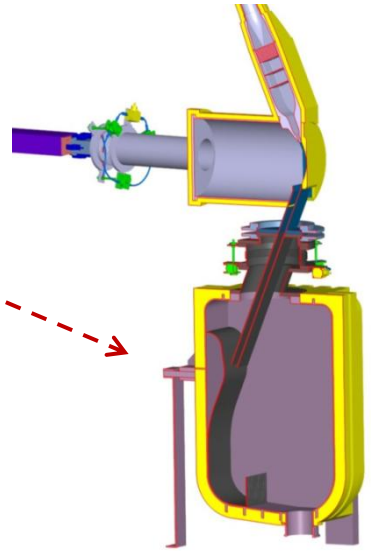
Lithium loops



Li volume ~14 m³
Li flow rate: ~100 l/s

Target Assembly





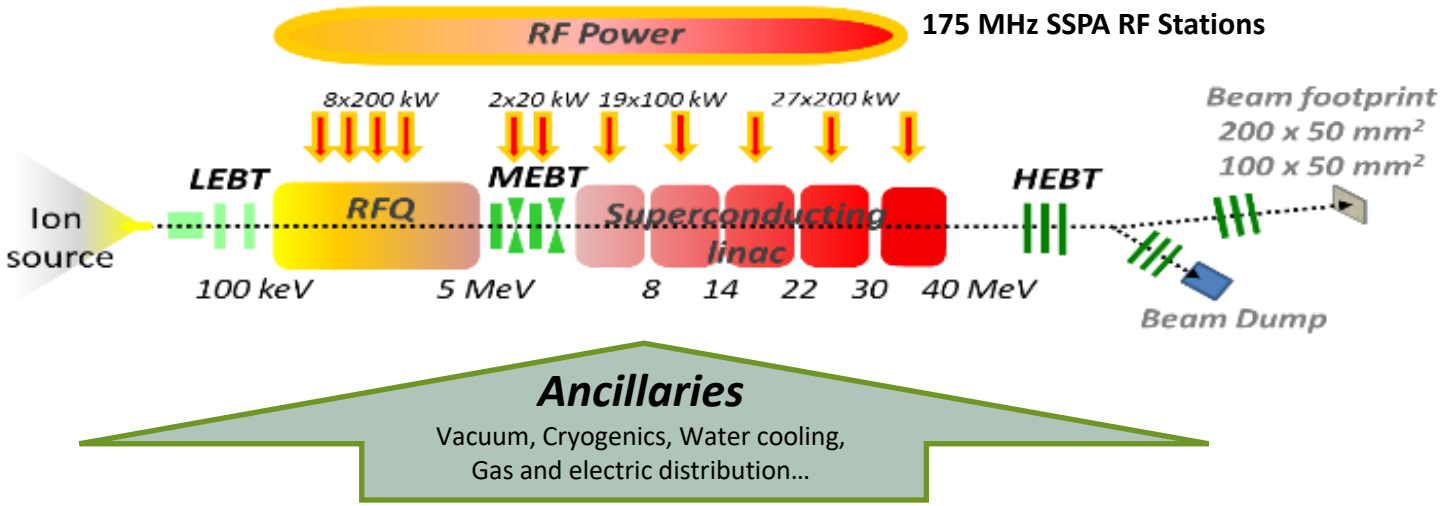
Heat flux: 500 MW/m²
Jet thickness: 25 ± 1 mm
Li inlet T: 300 °C
Li velocity: 15 m/s
Chamber pressure: 10^{-2} Pa

IFMIF/EVEDA ELTL validation results implemented in the design



H. Kondo, Fus. Eng. Design, 96-97, 117-122, 2015

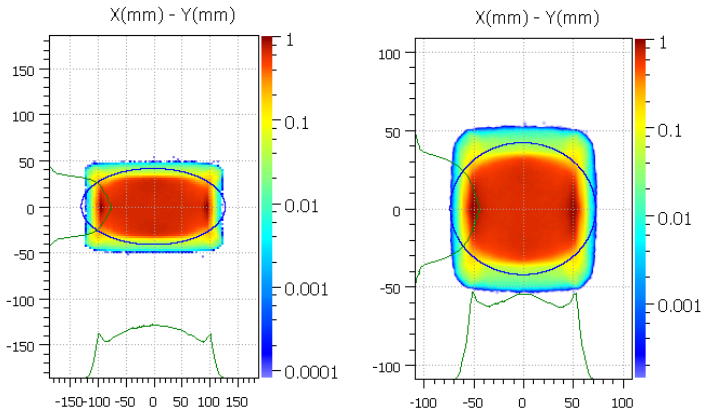
LINAC parameters



Ancillaries

Vacuum, Cryogenics, Water cooling,
Gas and electric distribution…

Beam footprint @ target



20x5 cm² footprint
(reference)

10x5 cm² footprint
(optional)

D+ CW 175 MHz SC LINAC

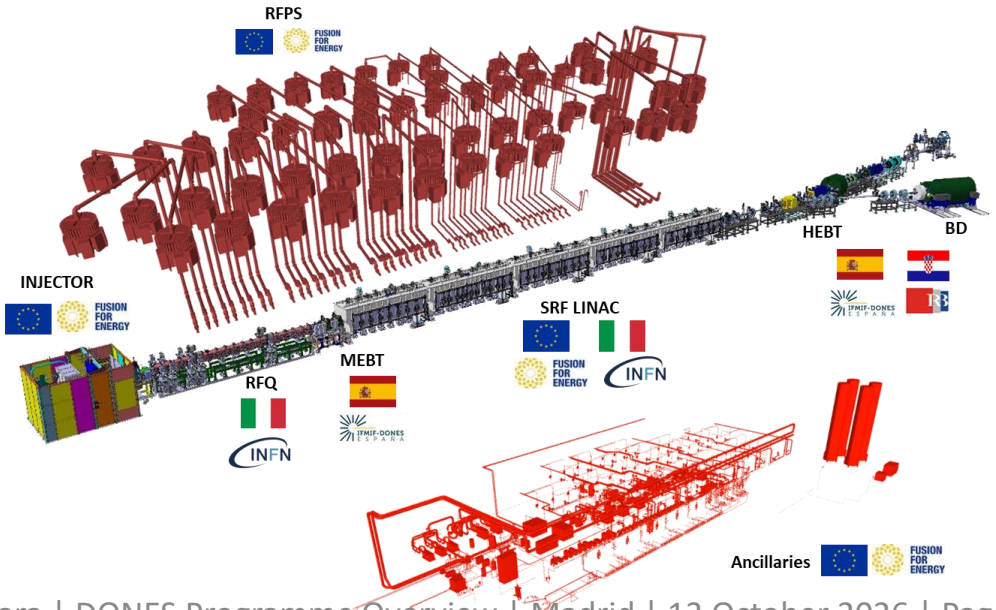
125 mA / 40 MeV → **5 MW**

Total length of ~**100 m**

Windowless liquid **Li target**

20 y, 87% **target availability**

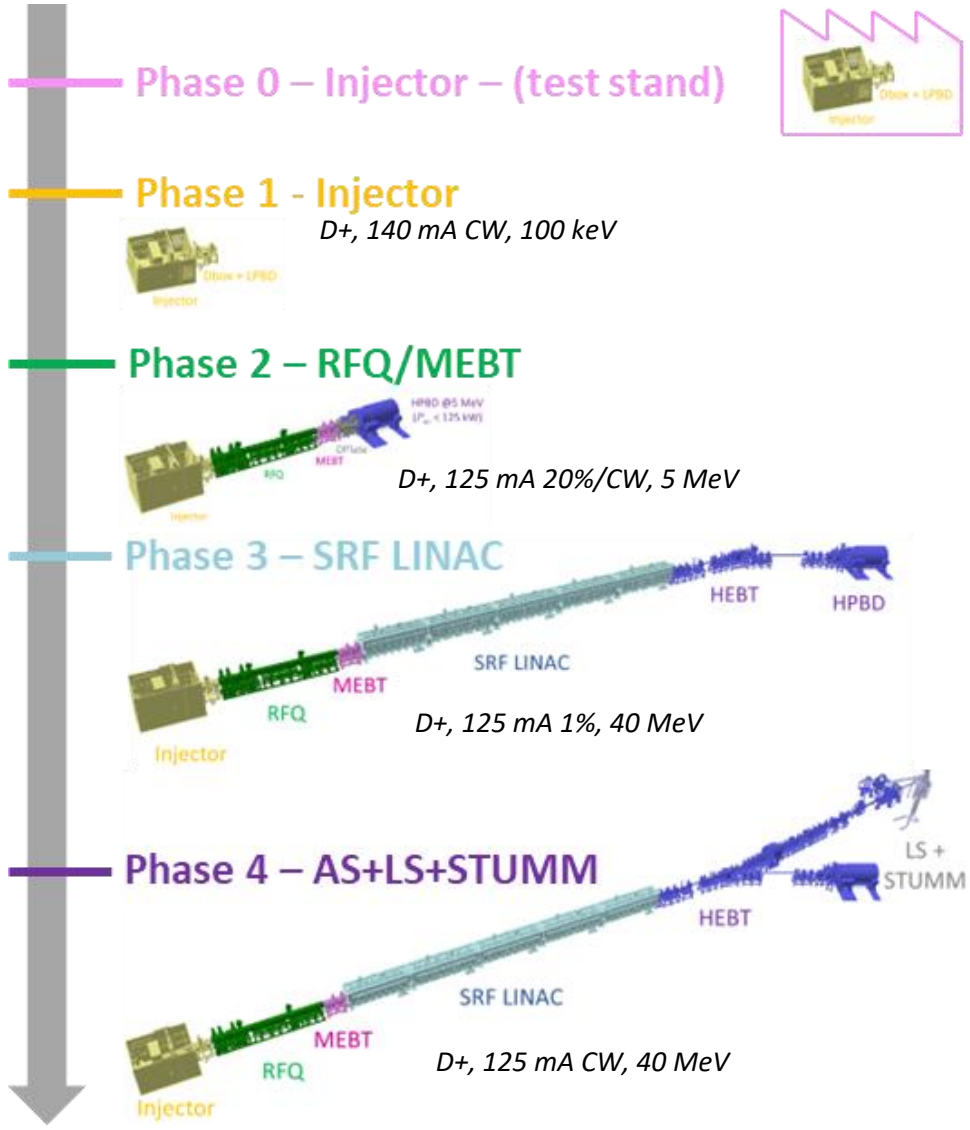
Hands-on **maintenance (<1 W/m)**



Commissioning & Operations Plan

- Main target → **Neutrons production with 40 MeV d(Li,xn)**
- **Staged Commissioning** similar to LIPAc and other facilities
- **Global Operation Modes** and **Control Logics** defined
- Lessons-learned from **LIPAc** and other facilities

Id.	Description	Beam destination
BE1	**Nominal operation**	**Lithium target**
BE2	Nom. Phase 1	DB2@Injector
BE3	Nom. Phase 2	HPBD@MEBT
BE4	Nom. Phase 3	HPBD@HEBT
BE5	Pulse p+ Phase 1	DB2@Injector
BE6	Pulse D+ Phase 1	DB2@Injector
BE7	Pilot p+ Phase 2	HPBD@MEBT
BE8	Pilot D+ Phase 2	HPBD@MEBT
BE9	Pilot p+ Phase 3	HPBD@HEBT
BE10	Pilot D+ Phase 3	HPBD@HEBT
BE11	Pilot D+ Phase 4	Lithium target
BE12	Experimental areas	Target@R026
BE13	Variable profile	Lithium target



Outline

3 DONES Irradiation Capabilities

DONES mission and objectives

DONES Programme Mission

- To test materials and to develop a comprehensive database on the effects of fusion-like neutron irradiation on the materials required for the construction of fusion power reactors
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DONES Programme Objectives

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1) Identify irradiation needs

2) Comparison with IFMIF-DONES experimental capabilities

3) Definition of an experimental plan

Fusion-like Irradiation Needs

Irradiation applications across fusion technologies

Structural and first-wall materials

Qualification for the fusion programme, DEMO and fusion power plants

Functional materials

Irradiation effects on breeding-blanket materials, diagnostics, heating systems and superconducting materials

Breeding blankets and tritium

Testing of breeding-blanket mock-ups and other tritium technologies

Components and mock-ups

Testing of breeding blankets, divertors, magnets and diagnostics

Research and validation

Nuclear physics

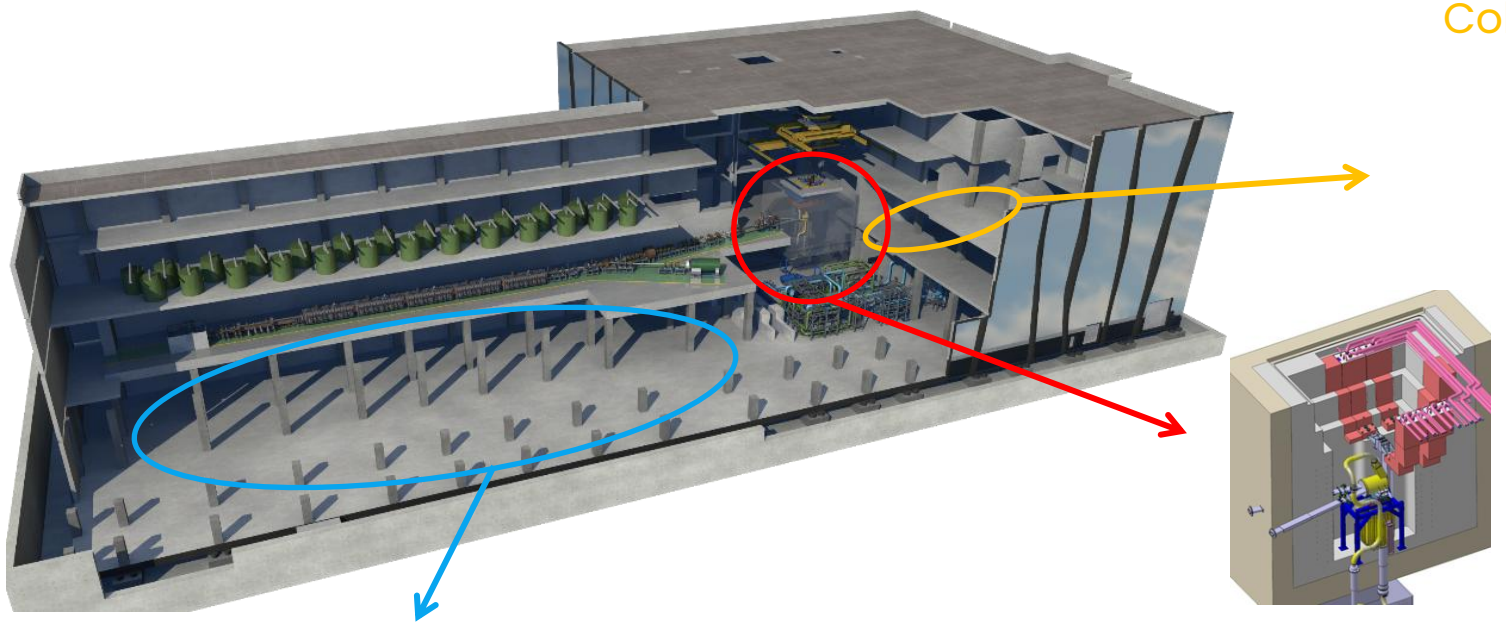
ITER-relevant studies

Experiments to benchmark computational materials science

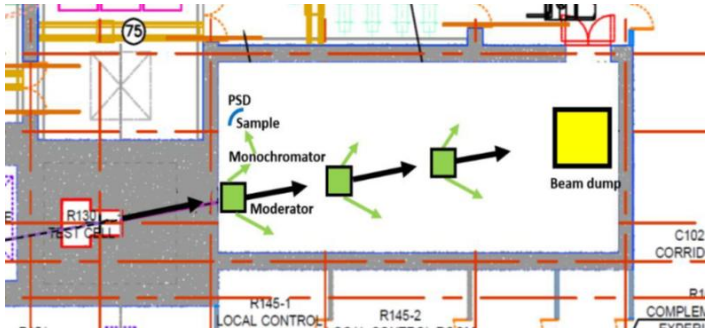


IFMIF-DONES Experimental areas

Three main experimental areas – First **Experimental Programme** to be presented this year

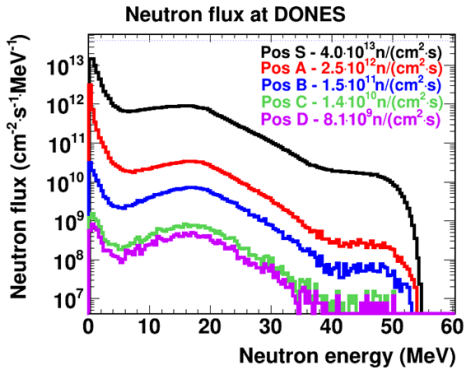


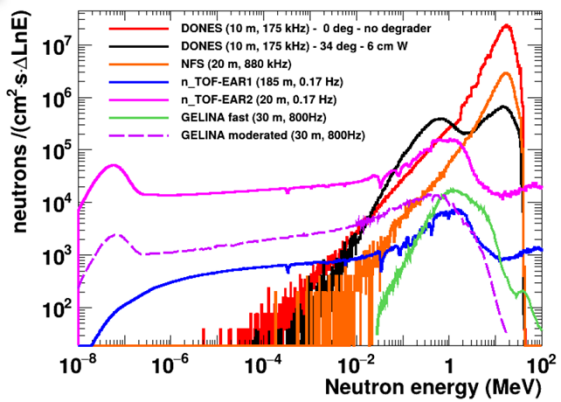
Collimated neutron beam facility - Area for complementary experiments with continuous neutron beam



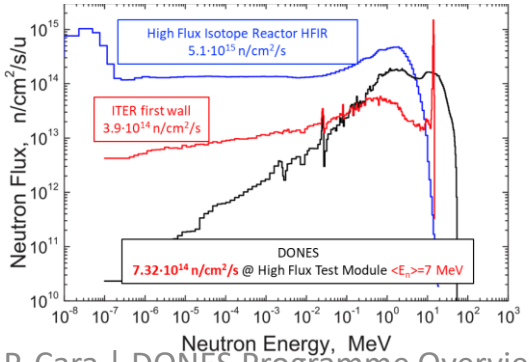
Area for complementary experiments with deuteron beam

Test cell – Main neutron experimental area (fusion users)



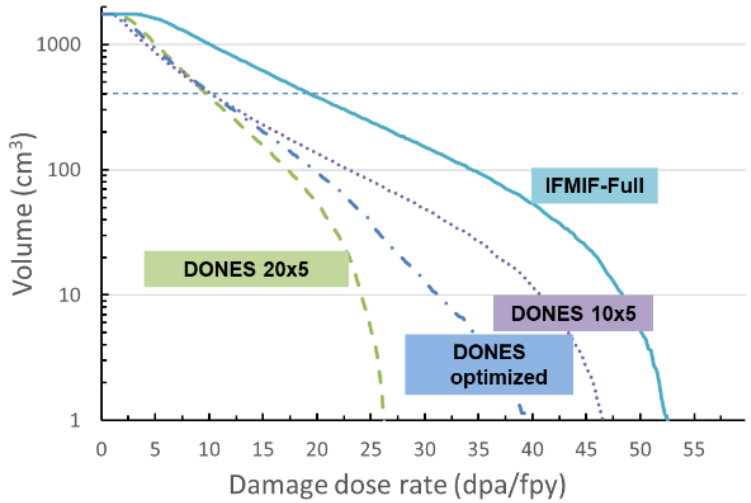


Design of TOF DONES ready (CIEMAT/NFUS)



Irradiation capabilities: flexibility

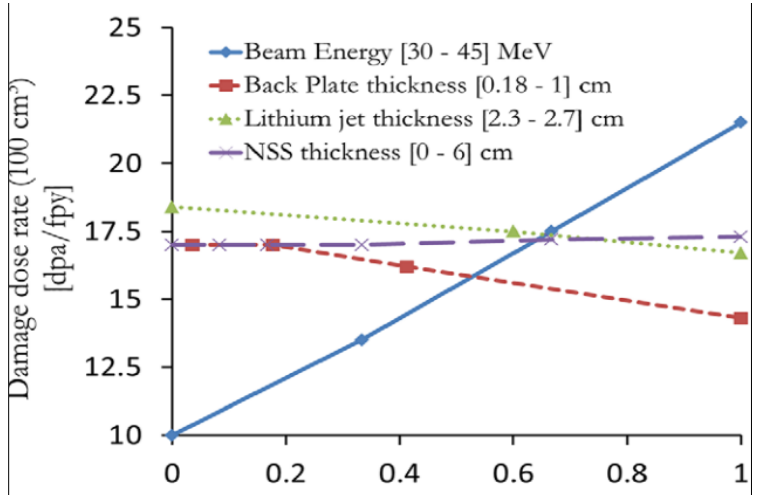
IFMIF-DONES design is **flexible**, in order to accommodate for different irradiation conditions



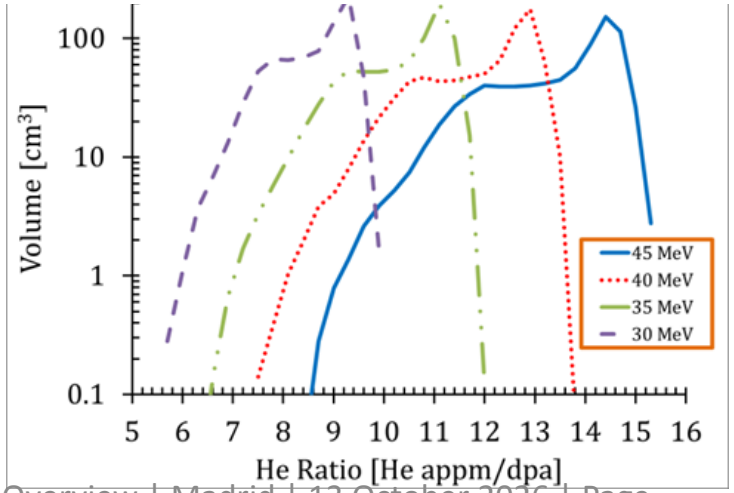
Flexibility on:

- Continuous or pulsed irradiation
- Dose rate (beam current and shape)
- Neutron spectra (i.e. He/dpa and H/dpa ratios)
- Temperature range
- Irradiation modules

Variation of the damage dose rate of the central part of the HFTM for different IFMIF-DONES parameters



Available irradiation volume of the central part of the HFTM vs He appm/dpa for different IFMIF-DONES D energy



Outline

4 DONES Experimental Programme

DONES Experimental Programme

DONES Experimental Programme is under preparation

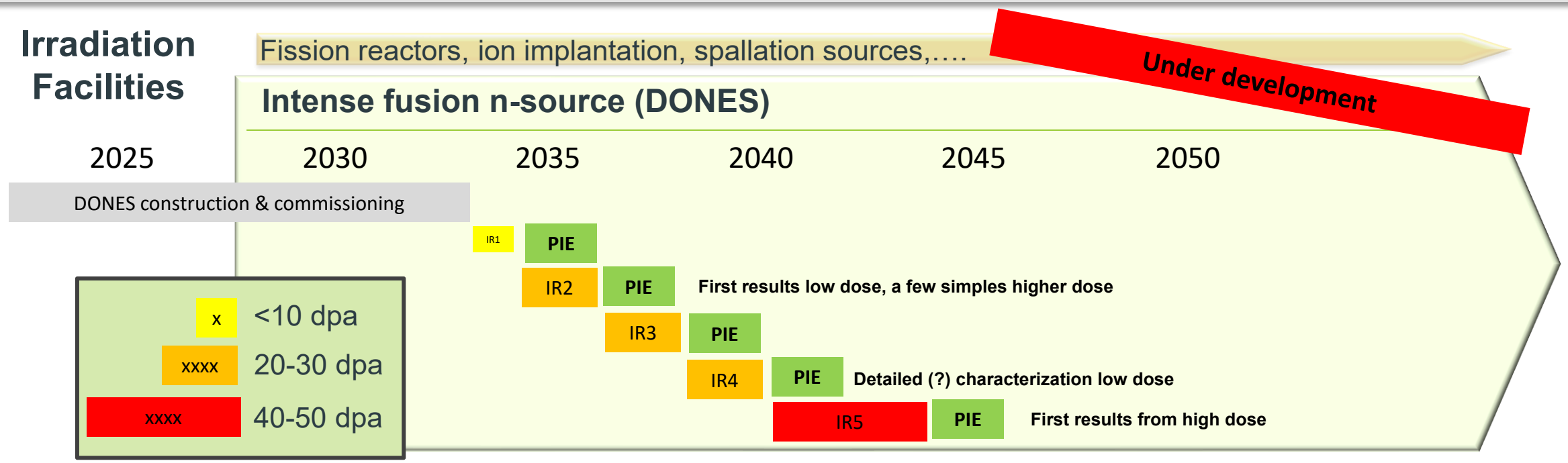
Irradiation capacity and complexity → requiring structured planning and prioritization of experiments.

Define priorities, organize commissioning experiments and experimental campaigns and optimize the use of irradiation capacity.

Strategic framework for the progressive expansion of experimental capabilities, including of the **IFMIF configuration**

To be submitted for approval by the DONES SC after recommendation by the STAC

Irradiation campaigns planning



Several irradiations campaign will be needed!!!

Priorities to be defined

Loading flexibility will be important

Reloading capability will be also implemented

Is it posible to speed up?

Most effective way:

- add second Accelerator (x2 faster from 2035)

Some improvement: additional paralelization of the construction and commissioning phase

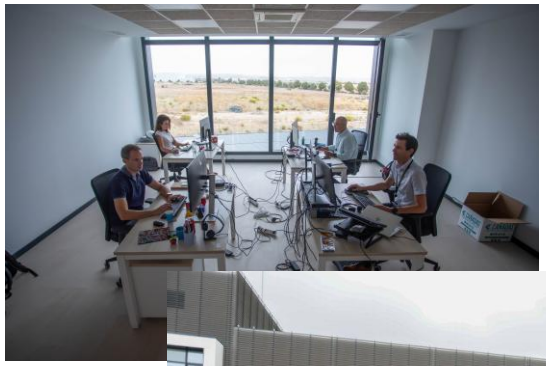
Some improvement: Implementation of some optional upgrades

Outline

5 Outlook & Summary

IFMIF-DONES Team at the DONES Hub











Onsite construction activities…

Headquarters – DONES Hub
&
Aux. buildings

Warehouse to host test stands
(i.e. Injector, RF Labs, …)



UGR DONES: Facility to test prototypes



Construction status: Site preparation Started







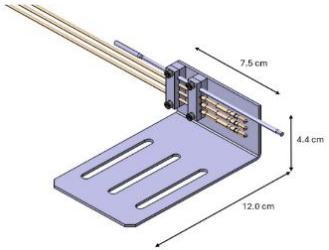
On-site facilities

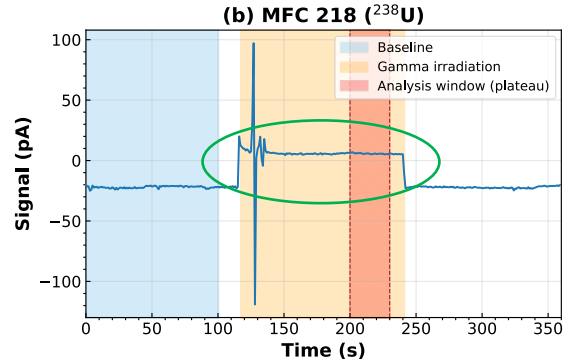
PROGRESS IN THE LAST 6 MONTHS

STUMM-PROTO

Full-scale Start-Up Monitoring Module prototype

Gamma irradiation of MFC and IC detectors at CNA's Co-60 source (Centro Nacional de Aceleradores, Seville). Tests assessed signal detectability before STUMM-PROTO: signals clearly exceeded noise with a representative setup using 35 m MI cables.





LITEC

Full-scale DONES Impurity Control System loop. First technical coordination meeting with CIEMAT completed. Integration work planned for October 2026.



LITEC / Full-scale ICS loop

LITHICA (Lithium Capability)

Design and construction technical specification in progress.

Critical Metals Storage Facility

Medium-capacity storage procurement started.

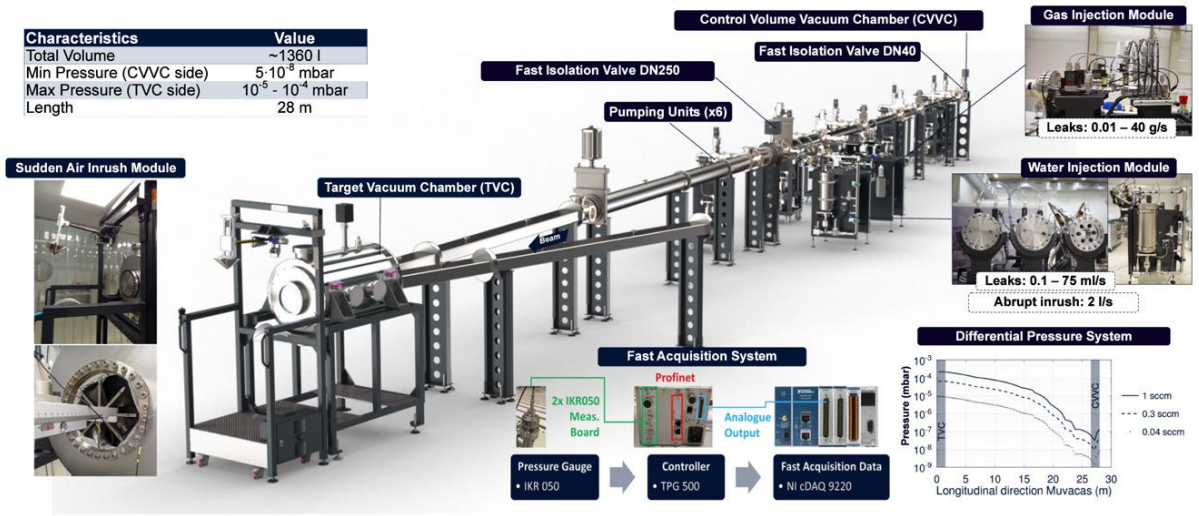
Liquid Metal Facility

Procurement of the first glovebox has started.

REMOTE

RH testing: phased approach agreed. Phase 1 design underway.

Ongoing research prototypes



A. Sabogal et al., Fus. Eng. Design, 222, 115473, 2026

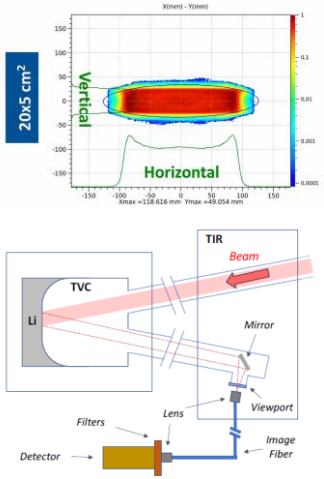
MuVACAS:
To validate protection of vacuum-related safety scenarios

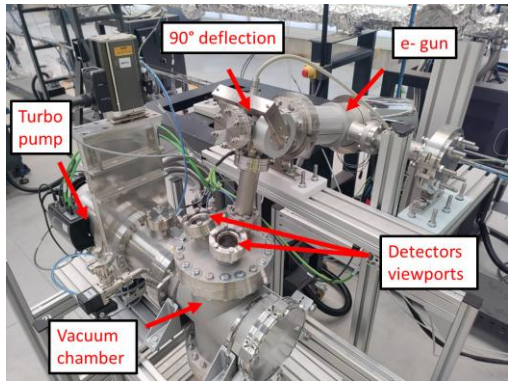
Quick Disconnecting System (QDS): To validate RH connection system at the target



G. Benzoni et al., Fus. Eng. Design, 215, 2025
A. Rodríguez et al., Proc. ISFNT16, 2025

Lithium OTR Light Detector:
To validate the OTR light from liquid lithium





J. Herranz et al., IPAC'26, WEP6074, 2026

Ongoing activities

esDONES ≈ €250M in contracts underway

Accelerator and test components, PLM, engineering support, safety, and site and building construction.

F4E +10 personnel assigned in Granada

Accelerator coupler procurement has started. Tenders for the Injector, RF Power System and other components are in preparation.

INFN Specifications and design advancing

RFQ and High Beta Cavities technical specifications are in preparation, alongside design work.

ENEA Contribution progressing

Work continues on the expected contribution, pending full membership.

100+ **People in Granada esDONES & F4E**



Engineering handover to the Programme Team complete

Procurement Arrangements: 4 signed (Buildings, MEBT, HEBT, Test Cell). 4 more expected by year-end.

Conclusions and outlook

2027

Pivotal implementation year

IFMIF-DONES
Conclusions & outlook

Construction underway

IFMIF-DONES has entered construction. Major-system procurement is progressing, with several components in final design and manufacturing.

Main building: ready in 2029

Civil works began in early September. The main building should be ready in 2029 for the first accelerator equipment.

Priorities for the next 6 months

Secure Providing Parties' commitments, reinforce Programme Team resources and mitigate risks to protect the current baseline.

Experimental Programme: end-2026

The DONES Experimental Programme and its capabilities are under development. A first version is planned for end-2026.

DONES

Thank you for your attention…

www.ifmif-dones.es

